Vector CONTROLLERS for BLDC Motors

Sine wave controller

State of Art Technology
Most Reliable - High Efficiency
Smooth control - Programmable

INTRODUCTION

Field-Oriented Control (FOC) is an important technology for motor systems, particularly those using permanent magnets (PM). In general, FOC provides an efficient way to control BLDC motor in adjustable speed drive applications that have quickly changing loads, and can improve the power efficiency of an AC induction motor, especially at lower speeds. For this reason, some designers mistakenly associate FOC for use only with AC motors. While it is true that today's brushless DC (BLDC) motors tend to very efficient, up to 96 percent even without FOC, the value FOC brings to these systems is reduced torque ripple, resulting in smoother motor performance and quieter operation.

In simple terms, FOC is a motor control technique where the system is trying to orient the stationary or "stator" flux vector to a specific degree relative to the rotor flux vector (see Figure 1). The optimal degree of orientation depends upon what characteristic of the motor needs to be maximized. The most common use of FOC is to maximize the motor's torque per amp. This is achieved when the stator flux vector is 90 degrees to the rotor flux vector unless the motor has a variable reluctance, such as a motor with a magnet buried inside it. In this case, the degree of orientation is typically 115 to 120 degrees.
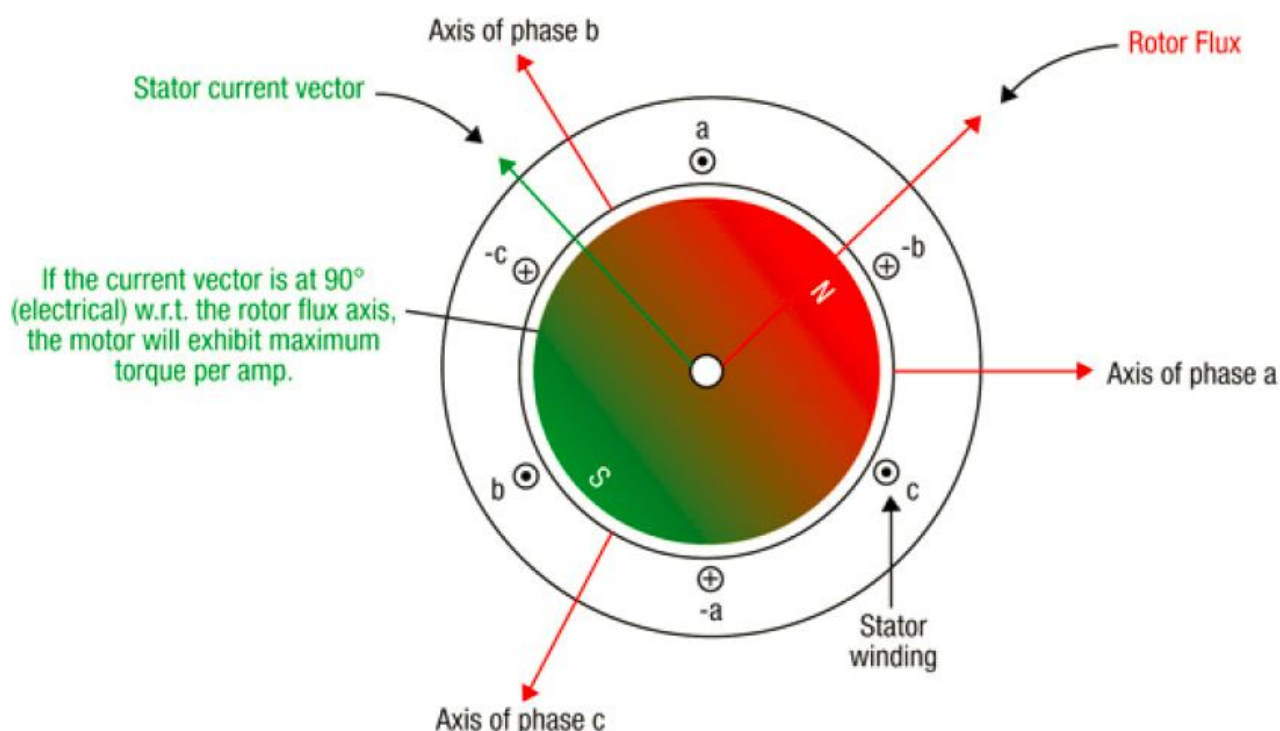
Figure 1: Field-oriented control techniques orient the stator flux vector to a specific degree relative to the rotor flux vector. (Source: Texas Instruments. Used with permission.)

MiroMax's offered FOC controller products are specially designed for high power rating brushless dc (BLDC) motors from 1KW up to 20KW with voltages between 48V and 96V.

The product series use the FOC (Field Oriented Control/Sine Wave) algorithm in which SVPWM is used to drive the power device so that it injects sinusoidal current to the three-phase of motor. Meanwhile, by using a 32-bit microprocessor which incorporates the latest ARM core, it exhibits excellent operational capability. The system handles several close loops which include torque, flux and speed loop and at the same time other high demand of real-time task operation is possible.

Application

- Electric Cars
- Electric Bike, Trike, Quad,
- Electric Motorcycles, Scooters
- Electric Golf , Buggies, Forklifts, ect.
- Application in industry
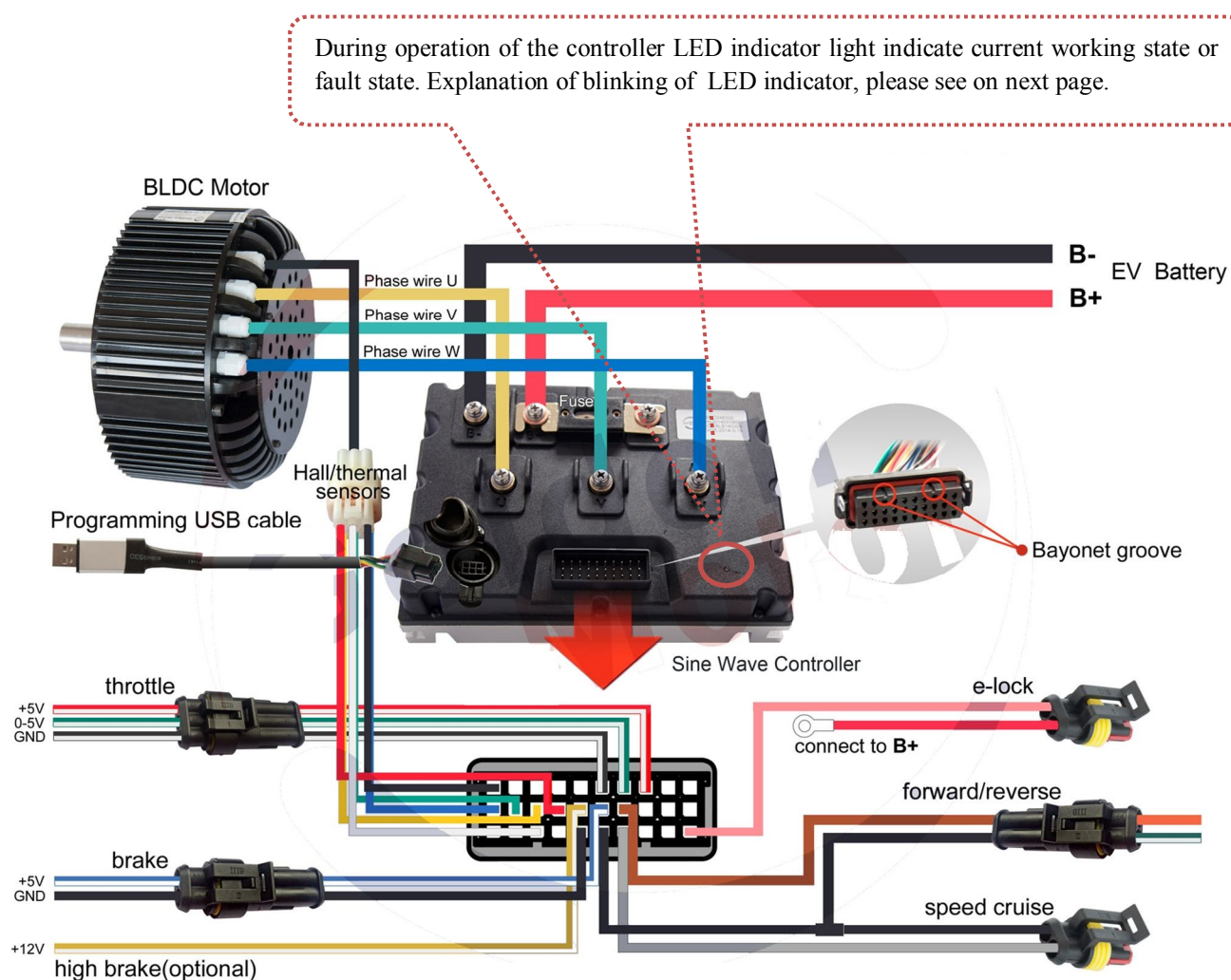
SINE WAVE (FOC) CONTROLLERS SERIES

VEC300	VEC500	VEC700

Sine wave controller

State of Art Technology
Most Reliable
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Smooth Control
Programmable

Model	Rated Voltage	Rated Current	Max Phase Current	Dimmension LxWxH (Weight)
VEC200-48	48V	100A	200A	170*120x50mm [1.9kg]
VEC200-72	72V	80A	200A	
VEC300-48	48V	120A	300A	
VEC300-72	72V	100A	300A	190*180*50mm [2.5kg]
VEC300-96	96V	80A	250A	
VEC500-48	48V	200A	500A	
VEC500-72	72V	150A	500A	200*190*58mm [3.2kg]
VEC500-96	96V	120A	450A	
VEC700-48	48V	500A	700A	
VEC700-72	72V	450A	700A	330x225x70mm [6.5kg]
VEC700-96	96V	400A	700A	
VEC700-120	120V			by individual order

During operation of the controller LED indicator light indicate current working state or fault state. Explanation of blinking of LED indicator, please see on next page.

BLDC Motor

Phase wire U
Phase wire V
Phase wire W

B- EV Battery
B+

Fuse

Hall/thermal sensors

Programming USB cable

Bayonet groove

Sine Wave Controller

throttle
+5V
0-5V
GND

e-lock
connect to B+

forward/reverse

brake
+5V
GND

+12V
high brake(optional)

speed cruise

REMARKS:

In different models of controllers:

1. The connection may be different (see chapter **Pin definitions and connection schematic**)
2. The location of the LED indicator of state may be in a different place.

ADVANTAGES

By advanced control solution the system can achieve the following performance:

- Maximum torque control,
- Constant power control,
- Speed closed loop control
- Regenerative braking.

Compared with traditional square wave motor controller, the PMSM controller has the following obvious advantages:

Smooth driving

Direct torque control, smooth start-up, excellent acceleration performance, especially in slow speed.

Low noise

Vector control sinusoidal current injection and smooth motor output torque, which fully suppress the low frequency noise caused by the fluctuations of motor torque.

Programmable via PC

- Provide PC software (GUI) to program motor and control parameters to fine tune the drive system.
- Operating status can be monitored in real-time.
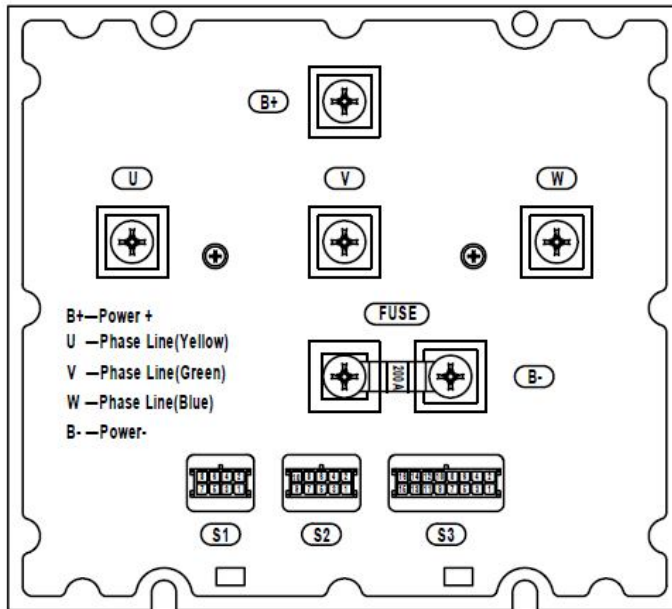- Support UART (standard).

Perfect protection function

- Signal integrity detection (motor interface signal, control signal, etc.)
- Over-current protection, over or under voltage protection and over-temperature protection.
- Provide motor temperature-control interface.

MAIN features

- On-site parameters tuning (Provide PC software)
- System power-on self-checking function
- Regenerative braking
- Brake, cruise, and three-mode speed selection interface
- Display interface
- LED for operation and fault status indication
- Compact design, which is convenient for vehicle installation

VEC 300

S1—Programming
- ①—GND（Black）
- ③—RX（Green&Yellow）
- ⑤—TX（Green）
- ⑦—+5V（Red）

S2—HALL Sensor
- ①—+5V（Red）
- ③—Ha（Blue）
- ⑤—Hb（Green）
- ⑦—Hc（Yellow）
- ④—GND（Black）
- ⑨—Motor Temperture（White）

S3—Function control wiring harness
- ①—
- ②—Electric Lock（Orange）
- ③—Speed Limit（White）
- ④—FUNC3（Green）
- ⑤—Reverse（Yellow）
- ⑥—
- ⑦—System Debuging（Brown）
  （NB:Only Used by Factory）
- ⑧—Cruise（Gray）
- ⑨—Throttle（Green&White）
- ⑩—
- ⑪—GND（Black&White）
- ⑫—GND（Black）
- ⑬—+5V（Red&White）
- ⑭—GND（Black）
- ⑮—Brake（Blue）
- ⑯—High Brake（Yellow&Green）

B+—Power +
U —Phase Line(Yellow)
V —Phase Line(Green)
W —Phase Line(Blue)
B- —Power-

VEC 300

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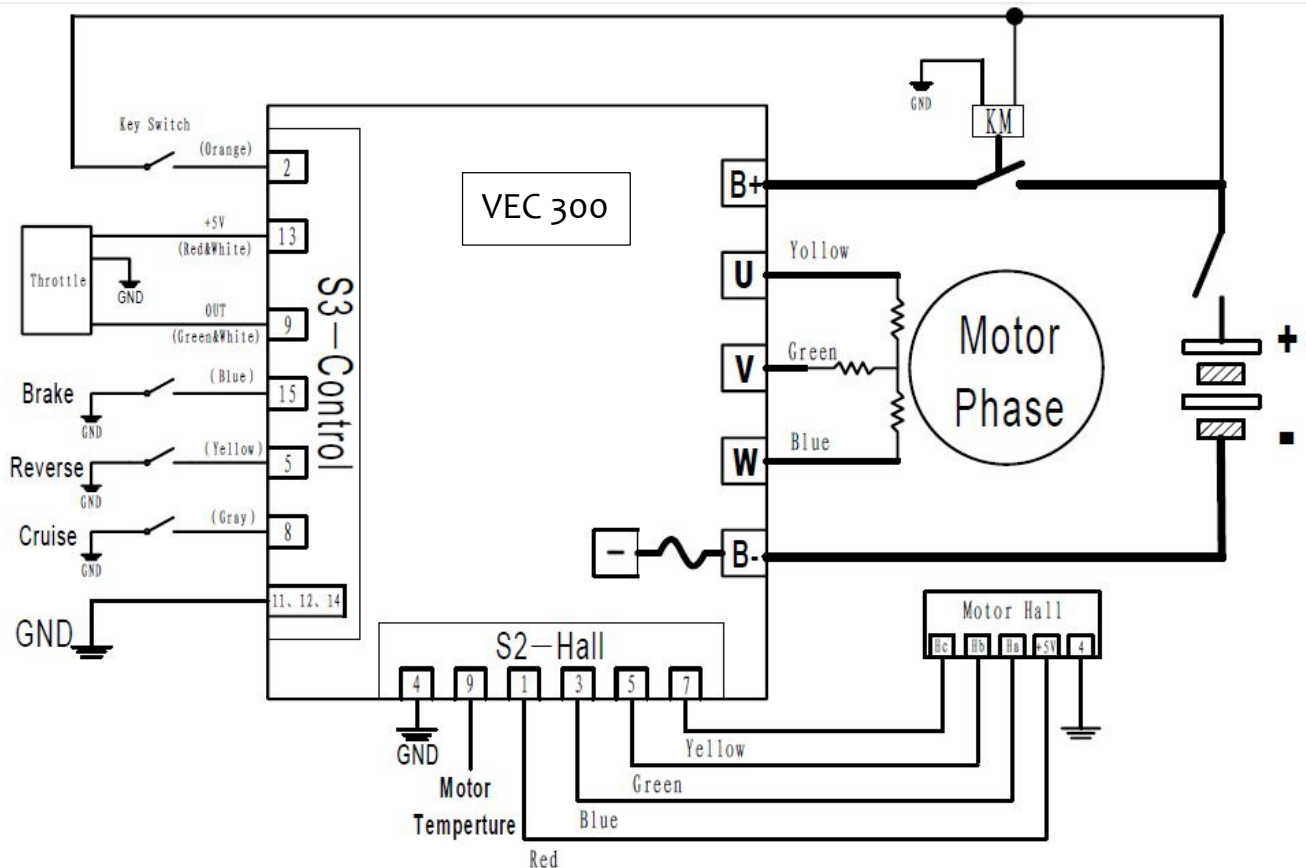
PIN DEFINITIONS and CONNECTION SCHEMATIC for VEC500

VEC 500

B+ —Power +
U —Phase Line(Yellow)
V —Phase Line(Green)
W—Phase Line(Blue)
B- —Power-

S1—Programming

①—GND（Black）
③—RX（Green&Yellow）
⑤—TX（Green）
⑦—+5V（Red）

S2—HALL Sensor

①—+5V（Red）
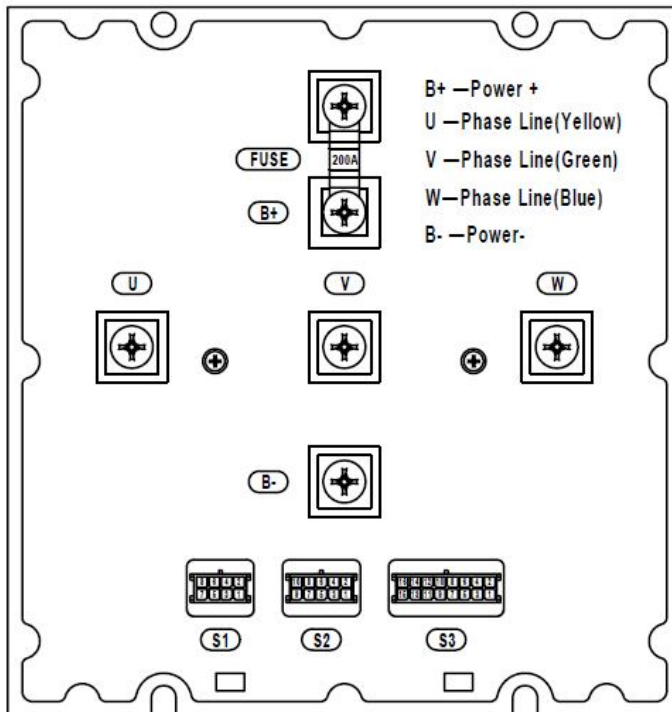③—Ha（Blue）
⑤—Hb（Green）
⑦—Hc（Yellow）
④—GND（Black）
⑨—Motor Temperture（White）

S3—Function control wiring harness

①—
②—Electric Lock（Orange）
③—Speed Limit（White）
④—FUNC3（Green）
⑤—Reverse（Yellow）
⑥—
⑦—System Debuging（Brown）
  （NB:Only Used by Factory）
⑧—Cruise（Gray）
⑨—Throttle（Green&White）
⑩—
⑪—GND（Black&White）
⑫—GND（Black）
⑬—+5V（Red&White）
⑭—GND（Black）
⑮—Brake（Blue）
⑯—High Brake（Yellow&Green）

VEC 500

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VEC 700

|	NO.(A)	31	32	33	34	18	30	1	13	4	15	3	14	25	24	10	20	7	18	5	16	8	9	19	11	12	22	23	35	21
A	Wire Color	Red	Yellow	Green	Blue	Black	White	Orange	Black	Yellow &Green	Black	Purple	Black &White	Green &White	Red &White	Gray	Black	Brown	Black	Pink	Black	Blue &White	Yellow &White	Black	Blue	White	Yellow	Green	Red	Black
	Function	Hall&Temp						Power		L-Brake		H-Brake	Throttle			Cruise		Reverse		BOOST		3-Speed			Programming					
	NO.(B)	1	2	3	4	5	6			1	2	1	1	2	3	1	2	1	2	1	2	2	1	3	3	2	4	5	1	6
B																														
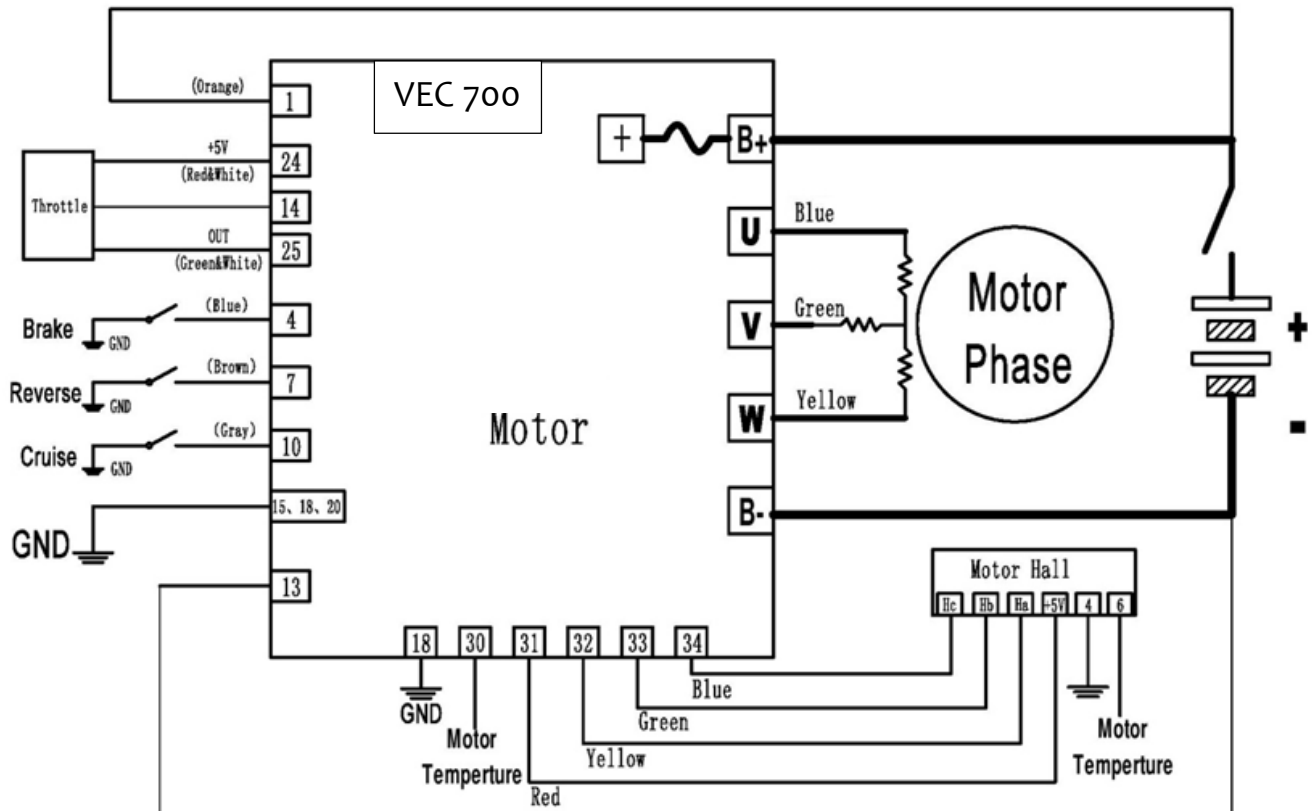
User guide of Programming

In order to set up necessary parameters into controller (or change them) we need to do following steps:

1. Download programming software from HERE
2. Install software

During the programming power supply of controller has to be TURNED OFF !
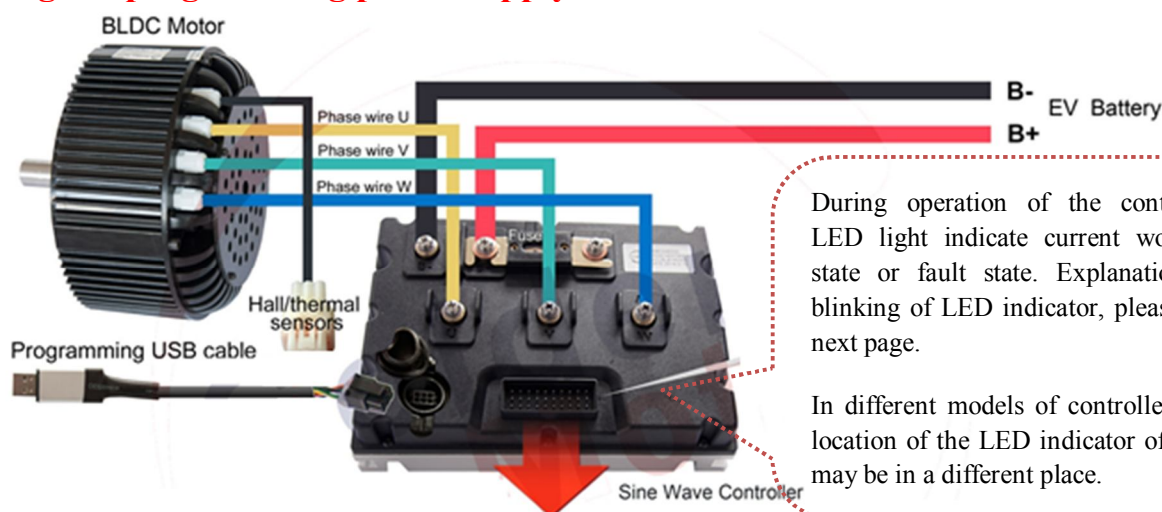
During operation of the controller LED light indicate current working state or fault state. Explanation of blinking of LED indicator, please see next page.

In different models of controller The location of the LED indicator of state may be in a different place.
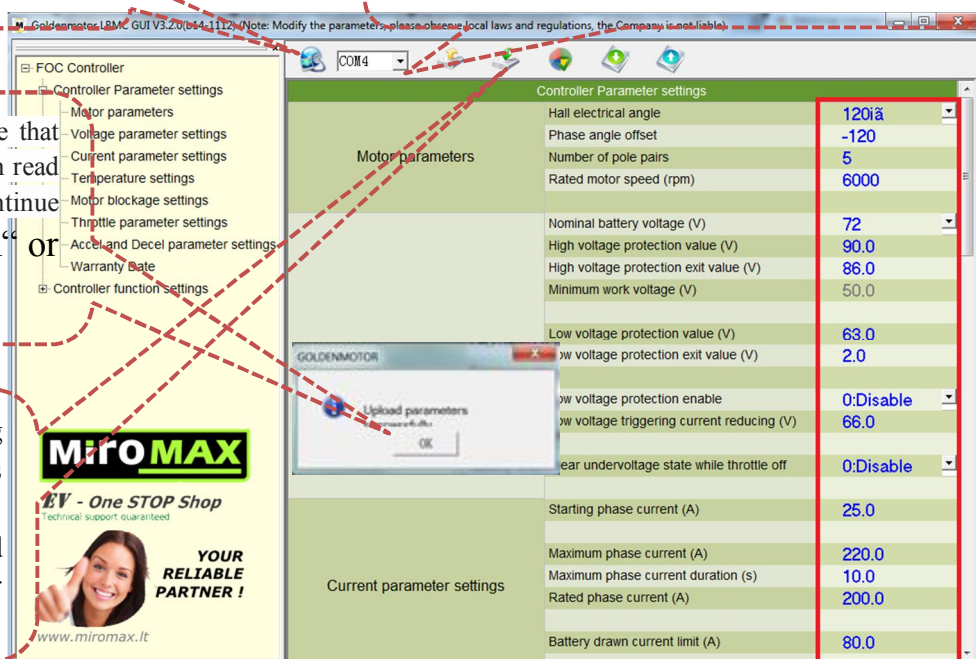
3. Connect controller to a PC with USB programming cable.
4. RUN installed software PI-800.

1. Select COM port, which is used for USB cable. (be aware that COM port number can be different that is is shown in a picture).

2. Now press this button. „*Connect to Controller*"

3. You will see a message that the controller configuration read successfully. To continue programming, press „OK" or ☒.

4. After changing parameters press "download" button. Then you will download new settings to your controller.

Controller Parameter settings	
Motor parameters	
Hall electrical angle	120iă
Phase angle offset	-120
Number of pole pairs	5
Rated motor speed (rpm)	6000
Nominal battery voltage (V)	72
High voltage protection value (V)	90.0
High voltage protection exit value (V)	86.0
Minimum work voltage (V)	50.0
Low voltage protection value (V)	63.0
Low voltage protection exit value (V)	2.0
Low voltage protection enable	0:Disable
Low voltage triggering current reducing (V)	66.0
Clear undervoltage state while throttle off	0:Disable
Current parameter settings	
Starting phase current (A)	25.0
Maximum phase current (A)	220.0
Maximum phase current duration (s)	10.0
Rated phase current (A)	200.0
Battery drawn current limit (A)	80.0

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After changing parameters, disconnect USB cable from controller and PC.
Now you can test your controller with new settings.

MEANING OF LED INDICATION ON THE CONTROLLER

During operation of the controller LED indicator light indicate current working state or fault state. Explanation of blinking of LED indicator, please see table below:

System Protection Characteristics		LED Blinking Times
Over-voltage protection	Battery voltage is higher than default value	1
Under-voltage protection	Battery voltage is lower than default value	2
Motor over-current protection	Motor phase is short-circuit or phase to ground is short-circuit	3
Motor over-heat protection	Motor temperature is higher than default value	13
Stalling protection	Motor stalling time is over default value	4
HALL protection	HALL input is abnormal	5
MOSFET protection	MOSFET self-checking is abnormal	6
Phase winding disconnect protection	One of the motor phase is disconnection	7
Self-checking error protection	System internal power-on self-checking is abnormal	10
Controller over-heat protection	When controller operation temperature is higher than default value	11
Throttle protection	Throttle input is abnormal	12

Communication Characteristics	
UART communication	UART interface: parameter configuration and working state monitoring
CAN communication	CAN interface: parameter configuration and working state monitoring **(by individual order)**
Bluetooth communication	Bluetooth wireless interface: parameter configuration and working state monitoring **(by individual order)**
LED indicator light	Indicate current working state or fault state